Paper 7, TDC Part-3
Chapter– 1, Fundamental Concept of Digital Electronics
Lecture - 5

By:

Mayank Mausam

Assistant Professor (Guest Faculty)

Department of Electronics

L.S. College, BRA Bihar University,

Muzaffarpur, Bihar

Fundamental Concepts of Digital Electronics

- **Exculsive-OR and Exculsive-NOR Operation :-**

The Exculsive-OR in short it is also called XOR (EX-OR).

This operation is widely used in the design of Digital System.

Ex-OR operation can be performed using the basic gates- NOT, AND and OR or through any of the universal gate NAND or NOR. Due to this Ex-OR operation is not referred as basic logic or universal logic.

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The XOR operation is defined as:- For a “N” input XOR Gate the output is “High (1)” when the number of input is/are “High (1)” state is/are odd, where $(\mathrm{N} \geq 2)$ else the output is “Low (0)”.

- The expression of XOR operation is given by

  Y = A XOR B XOR C XOR .... XOR N

  $Y = A \oplus B \oplus C \oplus .... \oplus N$

Where “ $\oplus$ “ represent XOR operation between two signal.

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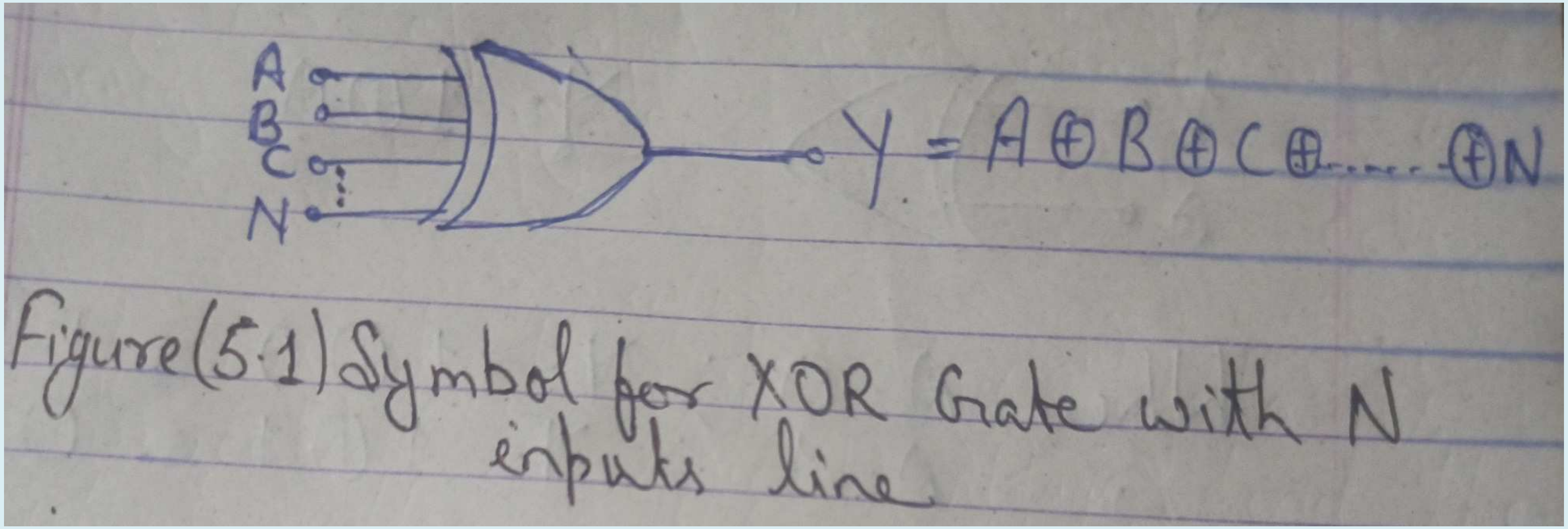
- **Symbol for XOR Gate : -**



Operation of XOR Gate with any numbers of inputs can be shown through its truth table.

- **<u>Truth Table for XOR Gate : -</u>**

The below truth table is of XOR Gate with 2 nos. of inputs.

Input (A)	Input (B)	Output (Y)
0	0	0
0	1	1
1	0	1
1	1	0

Truth Table for 2- Input XOR Gate

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As from the truth table we can see that when the odd nos. of input is at logic ‘1’ (that is in second and third row) the output is at logic ‘1’, else the output is at logic ‘0’.

XOR operation for three inputs signal can also be understand from the truth table.

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Input (A)	Input (B)	Input (C)	Output (Y)
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

<u>Truth table of a 3- Input XOR Gate</u>

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So from the truth table it is clear that when the odd nos. of input is at logic ‘1’ (that is in second, third, fifth and eighth row) the output is at logic ‘1’, else the output is at logic ‘0’.

In a similar manner we can write the operation of XOR logic with ‘N’ numbers of input signal in truth table form.

The XOR logic is used when two digital signals are to be compared.

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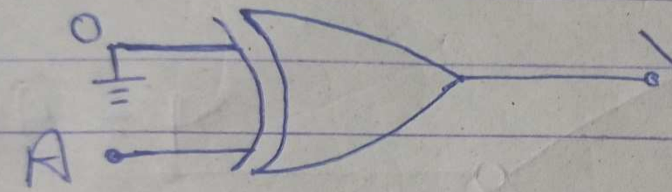
Example 1.1) Determine the relation between the output Y and one of its inputs for XOR operation, if its other input is connected to (a) logic '0' (b) logic '1'.

Solution:→

(a)



$Y = 0 \oplus A$

When $A = 0$, $Y = 0 \oplus 0 = 0$

" $A = 1$, $Y = 0 \oplus 1 = 1$

So the relation between the o/p Y and one of its input if other input is at logic '0' for a XOR operation is

$$Y = A$$

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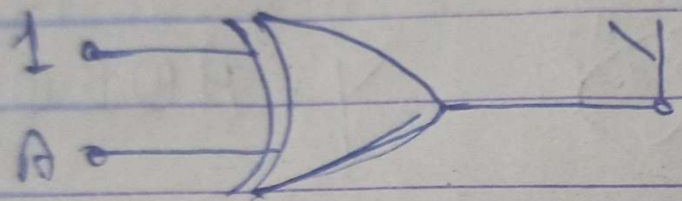
(b) If other input is connected to logic '1'



$Y = 1 \oplus A$

When $A = 0$; $Y = 1 \oplus 0 = 1$

" $A = 1$; $Y = 1 \oplus 1 = 0$

So here the relation is given by

$$Y = \overline{A} = A'$$

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Just like ‘NAND’ and ‘NOR’ logic which are complement of ‘AND’ and ‘OR’ logic respectively, the XNOR logic is complement of XOR logic.

The XNOR operation is defined as:- For a “N” input XNOR Gate the output is “High (1)” when the number of input is/are “High (1)” state is/are even, where $(\mathrm{N} \geq 2)$ and when all the inputs are at “Low (0)” state else the output is “Low (0)”.

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- The expression of XNOR operation is given by

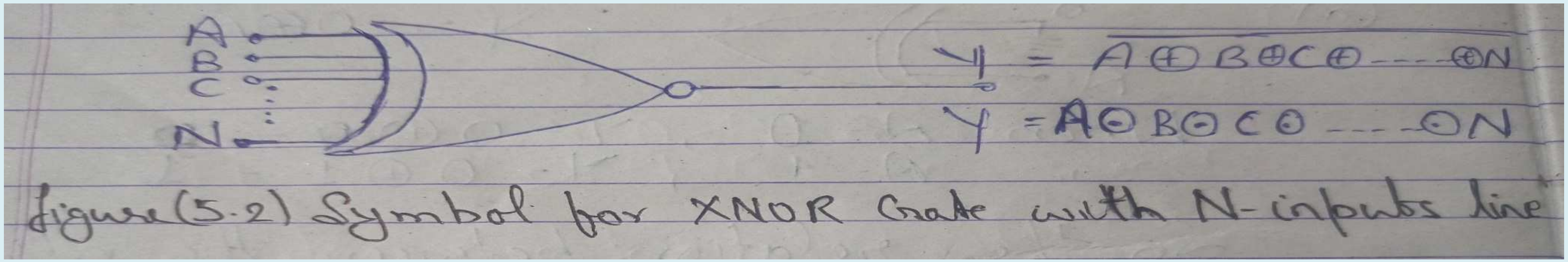
$$Y = \overline{A \text{ XOR } B \text{ XOR } C \text{ XOR } \ldots\ldots\ldots\ldots \text{ XOR } N}$$

$$Y = A \text{ XNOR } B \text{ XNOR } C \text{ XNOR } \ldots\ldots\ldots\ldots \text{ XNOR } N$$

$$Y = A \odot B \odot C \odot \ldots\ldots\ldots\ldots\ldots\ldots \odot N$$

Where " $\odot$ " represent XNOR operation between two signal.

<u>Symbol for XNOR Gate : -</u>



- **Truth Table for XNOR Gate : -**

Operation of XNOR Gate with any numbers of inputs can be represented through its truth table.

Input (A)	Input (B)	Output (Y)
0	0	1
0	1	0
1	0	0
1	1	1

Truth Table for 2- Input XNOR Gate

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As from the truth table we can see that when all the inputs are at logic ‘0’ (in first row) and the nos. of input is at logic ‘1’ (in fourth row) the output is at logic ‘1’, else the output is at logic ‘0’.

XNOR operation for three inputs signal can also be understand from the truth table.

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Input (A)	Input (B)	Input (C)	Output (Y)
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	0

<u>Truth table of a 3- Input XNOR Gate</u>

So from the truth table it is clear that when all the inputs are at logic ‘0’ (in first row) and the even nos. of input is at logic ‘1’ (in fourth, sixth and seventh row) the output is at logic ‘1’, else the output is at logic ‘0’.

In a similar manner we can write the operation of XNOR logic with ‘N’ numbers of input signal in truth table form.

The XOR operation is referred to as the coincidence operation.

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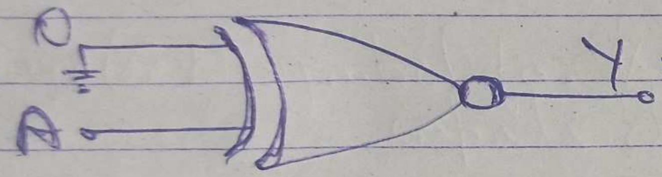
Example (1.2) Determine the relations between the o/p Y and one of its inputs for XNOR operation, if its other input is connected to (a) logic 0 (b) logic 1.

Solution.



$Y = \overline{0 \oplus A} = 0 \odot A$

When $A = 0$; $Y = 0 \odot 0 = 1$

" $A = 1$; $Y = 0 \odot 1 = 0$

So the relation between the O/P Y and one of its input if other input is at logic '0' for a XNOR operation is.

(b)

$Y = \overline{A}$

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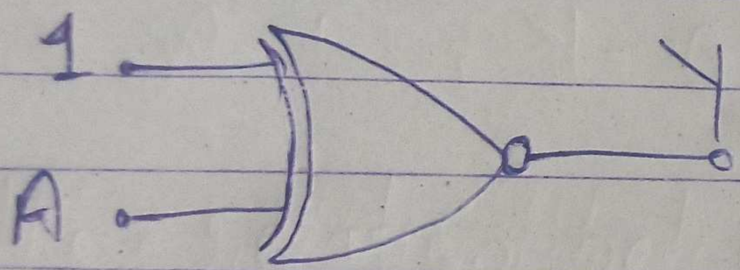
(b)



$Y = \overline{1 \oplus A} = 1 \odot A$

When $A = 0$; $Y = 1 \odot 0 = 0$

$A = 1$; $Y = 1 \odot 1 = 1$

So here the relation is given by

$$\boxed{Y = A}$$